CLAIMS

1. A method of diagnosing a subject by delivering ultrasound signals using shear waves, the method comprising:

applying a portion of an ultrasound mainbeam to a bone surface at an incident angle relative to the surface of the bone to induce shear waves in the bone, energy in the shear waves forming a substantial part of energy of first ultrasound waves at a desired region in the subject through the bone;

detecting at least one of reflected and scattered energy of the applied ultrasound mainbeam; and

analyzing the detected energy for a diagnostic purpose.

2. The method of claim 1 wherein the portion of the ultrasound mainbeam is applied to the bone surface between a longitudinal wave critical angle associated with the subject and a shear wave critical angle associated with the subject.

3. The method of claim 1 wherein the analyzing includes producing an image of at least a portion of the desired region.

4. The method of claim 3 wherein the desired region is a linear region along a line of transmission of the ultrasound mainbeam.

5. The method of claim 1 wherein applying the portion of the ultrasound mainbeam comprises applying the portion of the ultrasound mainbeam to bone.

6. The method of claim 5 wherein the bone is a skull, and wherein the portion of the ultrasound mainbeam is directed at the skull at the incident angle in order to reach the desired region within the skull.

7. The method of claim 5 wherein the desired region is one of a sinus cavity and an inner ear cavity, the method further comprising providing an indication of whether the desired region is at least partially fluid filled.

8. The method of claim 5 wherein the desired region is one of a tooth and a jaw bone, the method further comprising at least one of:

providing an indication of whether the desired region has at least one of a cavity and an abscess; and

obtaining an image of at least one of anatomy and blood perfusion of the desired region.

9. The method of claim 1 wherein the at least a first ultrasound mainbeam is applied in multiple pulses of different frequencies.

10. The method of claim 9 wherein the different frequencies are within a range of frequencies from about 0.3MHz and about 5MHz.

11. The method of claim 9 wherein the different frequencies are within a range of frequencies from about 1MHz and about 3MHz.

12. The method of claim 9 wherein the pulses have durations within a range of about 1 cycle to about 100 cycles.

13. The method of claim 9 wherein the different pulses have corresponding different amplitudes to compensate for different attenuation amounts associated with the different frequencies.

14. The method of claim 1 wherein the at least a first ultrasound mainbeam is applied

in a burst of multiple cycles, at least two of the cycles having at least one of different frequencies, different phases, and different amplitudes.

15. A system for diagnosing a subject by delivering ultrasound signals to a target region in the subject using shear waves, the system comprising:

a transceiver configured to transmit ultrasound energy;

directing means, coupled to the transceiver, for causing a portion of a mainbeam of the transmitted ultrasound energy to be incident upon a bone surface of the subject such that ultrasound energy in the portion of the mainbeam from the source will induce shear waves in the bone with energy in the shear waves forming a substantial part of energy of ultrasound waves at the target region; and

analyzing means, coupled to the transceiver, for analyzing energy from the portion of the mainbeam that is returned from the target region for diagnostic purposes.

16. The system of claim 15 wherein the directing means are configured to cause the portion of the mainbeam to be incident upon the bone surface at a first angle between a longitudinal critical angle associated with the bone and a shear critical angle associated with the bone.

17. The system of claim 16 wherein the directing means comprises at least one of (1) a positioner configured to mechanically direct a normal direction associated with the source toward the surface of the bone at the first angle, (2) a phase/delay adjuster, wherein the transceiver comprises a plurality of radiating elements, the phase/delay adjuster being configured to regulate at least one of phases and delays of the plurality of radiating elements to electronically steer at least the first mainbeam, and (3) an actuation regulator, wherein the transceiver comprises a plurality of radiating elements, the actuation regulator being configured to actuate the elements at different times to direct the mainbeam as desired.

18. The system of claim 17 wherein the positioner is configured to at least one of (1) couple to the subject and the transceiver in a fixed manner such that the normal is directed toward the surface at the first angle, and (2) mechanically adjust the transceiver such that the normal is directed toward the surface at the first angle.

19. The system of claim 17 wherein the transceiver comprises a plurality of elements configured to radiate ultrasound energy, the system comprising a controller configured and coupled to cause at least a portion of the transceiver to emit ultrasound energy, to process indicia of returned energy due to the emitted energy to determine an orientation of at least a portion of the surface relative to the transceiver, and to actuate only elements of the source that have their mainbeams at least partially directed at the portion of the surface between the longitudinal critical angle and the shear wave critical angle.

20. The system of claim 19 wherein the controller is configured to process the indicia of returned energy to form an image of the at least a portion of the surface.

21. The system of claim 15 comprising a controller coupled to the transceiver and configured to actuate the transceiver to produce the mainbeam for transmitting energy to the target region, wherein the surface of the subject is an outer surface of a skull of the subject.

22. The system of claim 15 comprising a controller coupled to the transceiver and configured to actuate the transceiver to produce the mainbeam in a plurality of pulses with different frequencies and amplitudes.

23. The system of claim 22 wherein the different frequencies are within a range of frequencies from about 0.5MHz and about 5MHz.

24. The system of claim 23 wherein the different frequencies are within a range of

frequencies from about 1MHz and about 3MHz.

25. The system of claim 22 wherein the pulses have durations within a range of about 1 cycle to about 100 cycles.

26. The system of claim 22 wherein the different amplitudes compensate for different attenuation amounts associated with the different frequencies.

27. The system of claim 15 comprising a controller coupled to the transceiver and configured to actuate the transceiver to produce the mainbeam in a burst of multiple cycles, at least two of the cycles having at least one of different frequencies, different phases, and different amplitudes.

28. The system of claim 15 wherein the analyzing means is configured to provide an indication of whether the target region is at least partially fluid filled.

29. A system for delivering ultrasound signals to a target region in a subject using shear waves, the system comprising:

a transducer device configured to transmit and receive ultrasound energy;

a controller coupled to the transducer device and configured to actuate the transducer device to transmit ultrasound energy toward the subject; and

a positioning device coupled to the transducer device and configured to ensure that a portion of a first mainbeam from at least a portion of the transducer device is directed at a portion of a surface of the bone at an incident angle between normal incidence and a shear critical angle associated with the subject such that ultrasound energy in the first mainbeam will induce shear waves in the subject and energy from the first mainbeam will reach the target region, with energy in the shear waves forming a substantial part of energy of ultrasound waves at the target region;

wherein the controller is configured to cause the transducer device to transmit energy in a

at least one of:

a single pulse including multiple cycles, at least two of the cycles having at least one of different frequencies, different phases, and different amplitudes; and

a plurality of pulses, with different pulses having a different frequencies and amplitudes; and

wherein the controller is configured to analyze ultrasound energy from the first mainbeam that is returned from the target region and is received by the transducer device to determine diagnostic information from the returned energy.

30. The system of claim 29 wherein the transducer device comprises a plurality of elements configured to transmit ultrasound energy, and wherein the controller is configured to inhibit actuation of at least one of (1) a portion of the transducer device configured to produce a second mainbeam that would be incident upon the portion of the surface of the subject at a second angle that is less than the longitudinal critical angle, and (2) a portion of the transducer device configured to produce a third mainbeam that would be incident upon the portion of the surface of the subject at a third angle that is greater than the shear wave critical angle.

31. The system of claim 29 wherein the different frequencies are within a range of frequencies from about 0.1MHz and about 5MHz.

32. The system of claim 31 wherein the different frequencies are within a range of frequencies from about 0.31MHz and about 3MHz.

33. The system of claim 31 wherein the pulses have durations within a range of about 1 cycle to about 100 cycles.

34. The system of claim 29 wherein the positioning device is configured to couple to the subject to mechanically orient the source relative to at least one of the subject and the bone as

desired.

35. The system of claim 29 wherein the transducer comprises a plurality of elements configured to transmit ultrasound energy, and wherein the positioning device is configured to affect phases of the elements to electronically steer the first mainbeam.

36. The system of claim 29 wherein the transducer comprises a plurality of elements configured to transmit ultrasound energy, and wherein the controller is configured to affect timing of actuations of the elements to electronically steer the first mainbeam.

37. The system of claim 29 wherein the controller is configured to provide an indication of whether the target region is at least partially fluid filled based upon the diagnostic information determined by the controller from the returned energy.

38. The system of claim 29 wherein the controller is configured to cause a second mainbeam to be directed at the target region to stimulate motion in the target region, and wherein the controller is configured to provide an indication of the motion in the target region based upon the diagnostic information determined by the controller from the returned energy.

39. The system of claim 38 wherein the first and second mainbeams have different frequencies.

40. The system of claim 29 wherein the controller is configured to cause second and third mainbeams to be directed at the target region to stimulate motion in the target region, and wherein the controller is configured to provide an indication of the motion in the target region based upon the diagnostic information determined by the controller from the returned energy.

41. The system of claim 29 wherein the controller is configured to produce an image

of at least a portion of the target region from the returned energy.

42. The system of claim 41 wherein the target region is a linear region of the subject and the controller is configured to produce a linear image from the returned energy.